


Application No. 09/587,074

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned "Version with markings to show changes made."

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Specification:

On page 9, line 12:

Referring to the cross-sectional view of FIG. 4A, an exemplary embodiment of the present invention includes a hybrid upper mirror having semiconductor mirror layers 35 and dielectric mirror layers 34. ~~FIG. 4A~~ FIG. 4B is a cross-sectional ~~at~~ of an exemplary embodiment shown in FIG. 4A wherein the layers have been removed for clarity. In an exemplary embodiment of the present invention a semiconductor anti-phase layer 30 is integrated into the ~~into the~~ hybrid semiconductor-dielectric mirror on the uppermost layer of the semiconductor mirror 35. In an exemplary embodiment, an ohmic contact 4,5 is then formed on the anti-phase layer 30. The optical thickness of the anti-phase layer 30 is preferably chosen so that the reflection from the ohmic contact is out of phase with the second semiconductor mirror. This feature suppresses lasing underneath the ohmic contact while allowing standard ohmic contact materials such as gold or gold-beryllium alloys to be used. In addition, if ohmic aperture 32 is kept reasonably small, on the order of about seven microns, the excessive loss at the perimeter substantially prevents lasing in the material under the ohmic contacts, thereby suppressing higher order modes and ensuring single-mode operation.

In the Claims:

1. (Amended) A vertical cavity surface emitting laser comprising:
 - a first mirror formed adjacent to a substrate;
 - an active region formed adjacent to said first mirror;
 - a hybrid mirror formed adjacent to said active region comprising,
semiconductor mirror layers,

an anti-phase layer deposited on said semiconductor mirror layers,

a dielectric mirror layers deposited on said anti-phase layer; and

~~an ohmic contact~~ a reflector formed on said anti-phase layer, within said hybrid mirror, wherein reflections from said ohmic contact reflector are substantially out of phase with reflections from said semiconductor mirror layers to and said anti-phase layer provide mode selective optical loss in order to suppress higher order modes.

2. (Amended) The vertical cavity surface emitting laser of claim 1 further comprising one or more current constriction apertures that inhibit current from being injected into material beneath said ~~ohmic contact~~ reflector.

8. (Amended) The vertical cavity surface emitting laser of claim 1 wherein said hybrid mirror further comprises:

a dielectric spacer layer formed on said anti-phase layer, wherein said dielectric mirror layers are distributed across said dielectric spacer layer and said ~~ohmic contact~~reflector, and wherein total thickness of said anti-phase layer and dielectric spacer is an integer multiple of a half wavelength.

13. (Amended) A vertical cavity surface emitting laser comprising:

A first mirror formed adjacent to a substrate;

an optical cavity formed adjacent to said first mirror;

~~a lateral index guide to suppress higher order modes, wherein said lateral index guide comprises~~ comprising

a hybrid mirror having semiconductor mirror layers;

a dielectric spacer layer formed on said semiconductor mirror layers; and

dielectric mirror layers formed on said dielectric spacer layer, wherein ~~the~~ thickness of said dielectric spacer layer is spatially varied to radially alter resonant cavity wavelength of said VCSEL and thereby providing a lateral index guide.

14. (Amended) The vertical cavity surface emitting laser of claim 13 further comprising:

an anti-phase layer formed on uppermost semiconductor mirror layer, and

an ohmic contact formed on said anti-phase layer, wherein said ohmic contact and said anti-phase layer provide spatially varying optical loss so as to ~~further~~ suppress higher order modes.

17. (Amended) A method of fabricating a single mode vertical cavity surface emitting laser comprising:

forming a first mirror on a substrate;

forming an active layer and cavity on said first mirror layer;

forming a semiconductor mirror on said active layer;

forming an anti-phase layer on said semiconductor mirror layer;

forming an ohmic contact on said anti-phase layer; and

~~forming a dielectric mirror on said anti-phase layer;~~

wherein said ohmic contact and said anti-phase layer provide mode selective optical loss to suppress higher order modes.

20. (Amended) A method of fabricating a ~~single-mode~~ vertical cavity surface emitting laser comprising:

forming a first mirror on a substrate;

forming an active layer on said first mirror layer;

forming a second mirror on said active layer;

forming a dielectric spacer layer on said second mirror layer;

forming a dielectric mirror on said dielectric spacer layer; and

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varying phase of said dielectric spacer layer to form a lateral index guide, ~~thereby suppressing higher order modes.~~

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